ACETYLENE GAS AS THE ILLUMINANT IN PHOTOMICROGRAPHY.

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In a paper on Photomicrography, read at the meeting of this society at Ithaca, in 1895, I stated that the lately discovered acetylene light bade fair to be the best of all artificial illuminants for this work. At that time, my knowledge of it was limited to the occasional and ofttimes incorrect accounts of its wonders furnished by the newspaper press. I had never seen its light, and practically was utterly ignorant upon the subject. But the descriptions of its extraordinary brilliancy, whiteness and steadiness, seemed to infer a high photographic value, and led me to predict what has since that recent date been abundantly proven to be absolutely correct. To be sure, an English scientific (?) journal about that time asserted that exhaustive experiments showed the light to possess no photographic value whatever, and that the expectations of those who proposed to use it for the purpose were doomed to disappointment. It is not the first recorded instance of expert mistakes. Facts are stubborn things, and now, when acetylene is being used not only in photomicrographic work, but for making exposures in the daily work of photograph galleries, it must be conceded that the journal in question was mistaken in its statement.

A perfect light has been the desideratum of the worker in photomicrography from the beginning. Direct sunlight properly controlled and directed is very nearly but not quite this. It varies greatly in intensity with the season and the hour of day. It is rarely available in the confined limits of a city work-room and never at night, the only time when most of us have leisure to devote to this work. A heliostat and

other more or less costly apparatus are necessary for use with it. None but the favored few can ever hope to invoke its aid with any degree of regularity.

Next in order of perfection, the oxy-hydrogen or lime light may possibly be placed, though acetylene is certainly its worthy peer. Provided with a pair of charged cylinders, a properly constructed jet, and skill in the manipulation of the apparatus, the photomicrographer has at his command a very perfect and entirely satisfactory source of light for his work. But the necessarily considerable cost of the outfit with the expense of maintaining it, to say nothing of the difficulty or impossibility of recharging the cylinders, in many localities, must always restrict its use to a very limited field.

The light of burning magnesium is exceedingly actinic and useful for photomicrography, permitting very short exposures. But numerous objections have always prevented its extensive use. The fumes and heavy volumes of smoke attendant upon its combustion are very unpleasant, to put it mildly. It is difficult to determine the proper length of exposures, and the cost is somewhat of a serious item to many. The electric arc light is most excellent, but, for obvious reasons, quite beyond the reach of most of us.

It follows, then, that to the present time, the one and only generally available light for our work has been that of the old, familiar, omnipresent coal-oil, kerosene or petroleum lamp. Far be it from me to say aught against an old friend upon whose services I have relied for many years. Rather let me give thanks for the good it has done. Yet it must be confessed its many faults fully equal its virtues. Its perfume is not that of roses nor its temperature suggestive of coolness on a hot summer evening. Its yellow, non-actinic rays, though suitable for some classes of subjects, are quite the opposite with a majority ; requiring prolonged exposures, tending to a slight fogging of the plate, with increased danger of a bleared image from movement of the camera or microscope. Its negatives rarely possess the brilliancy or crispness of those made by whiter and more actinic lights.

I have made more than a thousand negatives with its aid, but very few of them compare favorably in these particulars with those I have exposed under the acetylene light during the past eight or ten months.

Early in the autumn of last year it was my good fortune to make a practical acquaintance with acetylene, under circumstances and conditions which speedily led to familiarity, and it has continued to be a daily and nightly companion ever since, with increasing appreciation of its superlative value for all purposes requiring artificial illumination. Absolute steadiness, light brilliant and white, but utterly devoid the ghastly whiteness of the Welsbach burner, in fact "a chunk of sunlight" (the spectra of the two being almost identical), no appreciable heat, no odor whilst burning, moderate cost of the apparatus for generating it, with extreme portability, simplicity, safety and ease of manipulation, and almost inappreciable expense of maintenance, combine to render acetylene the ideal illuminant in photomicrography.

It is not my intention in this paper to say aught regarding the manipulation of light, microscope or camera, leaving those subjects to other and abler pens. Our respected president, Dr. Mercer, has already published such exhaustive, yet simple, and admirable articles on these subjects that nothing original remains for me. I should merely quote from him were I to enter upon them. I shall, therefore, speak only of the light itself. This is so highly actinic that it may be safely stated, in a general way, that the average length of exposures are not over one-fifth of those required with the best coal-oil lamp, in many cases not exceeding one-tenth of the latter.

The form and size of burner may be varied at will, though it should never exceed one cubic foot per hour in capacity. My most satisfactory work has been done with burners of one-tenth that size. To insure perfect steadiness, it should be enclosed in a metallic case with glass front, as the acetylene flame is very susceptible to draughts of wind. I have here four different arrangements of burners and cases,

all of which have proved extremely satisfactory. The first is a Russian iron box, 4 by 4 by 2 inches, with open top and bottom, the front of glass and the whole carried on an upright rod, to which it can be secured at any desired height above the table. The burner is of one-foot capacity, set edgewise to the glass front, affording a very brilliant and powerful light. The second consists of three pencil-like flames set in line one behind another, each having a metal diaphragm in front with an opening of one centimeter. These being set in one line, an intensely brilliant light of great depth is obtained with a very small consumption of gas. For the general idea embraced in this arrangement I am indebted to Dr. G. M. Sternberg, Surgeon-General, U. S. A., who used it a number of years ago with ordinary street gas, and described it in his well-known and valuable work on Photomicrography.

The third arrangement is simply one which I originally designed for a microscopic illuminator, but which has proven in practice to be still more valuable for photomicrography. It consists of a burner of about one-eighth cubic foot capacity, set in a small metallic casing, with front closed by an ordinary glass microscope slide, which can be removed or replaced at a moment's notice, if broken. The glass may be dispensed with if desired. Its only use is to guard against possible draughts and to insure absolute steadiness in the flame. The interior of the case may be whitened by plaster-of-Paris or coated a dead black, at will. I prefer the latter. This little lamp is carried upon an upright, with adjustments for height and inclination. The light is exceedingly brilliant, absolutely white and the consumption of gas almost infinitesimal. A modification of this lamp, suggested by Hon. A. A. Adee, of Washington, is also shown. In this, the glass slip front is replaced by a blackened strip of brass, with an opening of one centimeter opposite center of the flame. It is very satisfactory in use, but I have not found it to be any better than the plain glass slip.

My own practice is to render the light monochromatic by

means of a cobalt blue cell placed in substage of microscope. If both focusing and exposure be made under this light, I think there can be no doubt of superiority in sharpness of definition and crispness in general effect of the negative. The length of exposure is somewhat increased, but not to any great extent.

Among the many advantages of acetylene not the least is the absence of appreciable heat attending its use for our purpose. No one who has attempted to make a photomicrograph by the light of a coal-oil lamp on a warm night has failed to be sensibly impressed with its fervid qualities; a good friend indeed, but rather too warm for the season. The small area of the acetylene flame and limited consumption of gas render it an essentially cool one, and entirely odorless as well.

The crowning advantage of acetylene, however, is its absolute uniformity. Sunlight varies under differing conditions, as is well known. So do all artificial illuminants hitherto in use. The so-called standard candle power is a delusion and a snare. It has been tolerated so long as the unit in light measurements simply because nothing better has hitherto been available. But it seems to me that in acetylene we have the long hoped for and perfect standard. This gas seems to be staple ($92\frac{1}{2}$ parts of carbon to $7\frac{1}{2}$ parts of pure hydrogen), whether generated from calcium carbide, yielding four cubic feet or less to the pound, or the very richest, of more than six cubic feet. Given a burner, a known capacity, say one consuming a cubic foot per hour under a predetermined and uniform pressure, for instance, of two inches of water, the light produced would always be the same, no matter whence or by whom. It would thus seem to be a very simple matter to fix upon a burner of suitable capacity and the best pressure to give to the world a standard unit of light, from which measurements could be made with a far greater degree of accuracy than is possible at present. A two-inch pressure is suggested, as being about that used in the distribution of ordinary illuminating gas. It might be also that a burner of much less capacity than one foot would be better than the

latter. Careful experimentation by competent persons would doubtless give certain and reliable results. I am only able to make the suggestion. I think it is a subject entirely within the scope of our society, and earnestly recommend that it take some action in the matter. It would be a very gratifying thing for it to have the honor of naming a universal standard unit of light. In my opinion, this is to be found in acetylene. Will not our society take hold of the matter in earnest and prompt manner?

An important factor in the successful use of acetylene for photomicrographic as well as other purposes, is the steady, automatic generation of the gas from calcium carbide, and its delivery, under uniform pressure of proper extent, to the burners in a dry, cool state. These conditions appear to be very satisfactorily filled by the "Monitor" automatic acetylene generators, manufactured by my house, Walmsley, Fuller & Co., of Chicago. These machines are extremely simple in design and construction, easily managed by anyone, perfectly automatic in operation, and absolutely safe. A nominal water pressure, never exceeding three inches, is all that can possibly be used with them. The holder carrying the carbide serves also as a gasometer, rising in the tank and lifting the carbide out of the water, so that generation of gas ceases when not burning. They are made in many sizes, all however embodying the same general principles. The gas may be turned on or off at pleasure and is always ready for use at a moment's notice. The smallest size will light one or two reading lamps, the larger a house or a block. They are moderate in cost, both as to that of the machines themselves and the production of the gas. At the present price of calcic carbide the cost of the light, compared with a given amount obtainable from ordinary street gas, is about the same as the latter would be at eighty cents per thousand feet, one cubic foot of acetylene giving as much light as thirty feet of ordinary gas.